Critical Point Scans at RHIC Full Energy

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"The QCD Critical Point Workshop"

INT, Aug 13, 2008

n_B/s is a "figure of merit" for any isentropic trajectory

How much experimental control do we have?

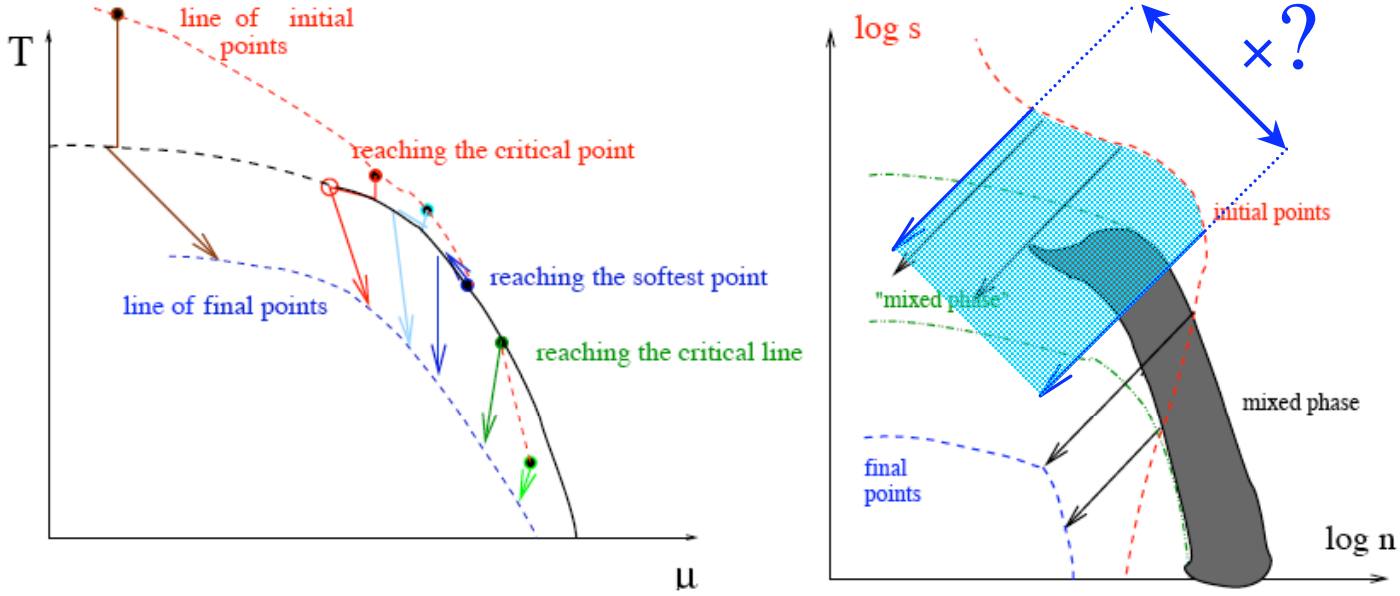
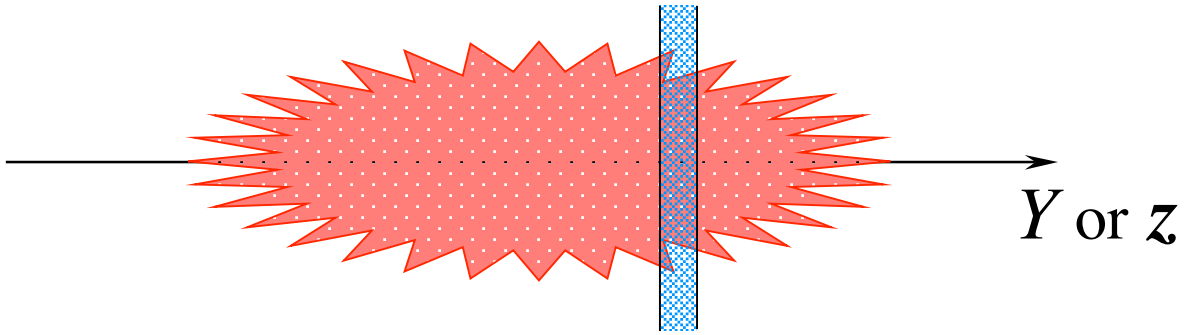


Figure 2: Schematic view of the cooling paths on (a) $T-\mu$ and (b) $log(s)-log(n)$ diagrams. In (a) those paths are zigzag-shaped lines with arrows, extended from the (red dashed) line of the initial points, to (blue dashed) line of the kinetic freezout. In (b) the same lines are a set of parallel straight lines.

E. Shuryak, POS (CPOD2006) 026

"All thermodynamics is local"



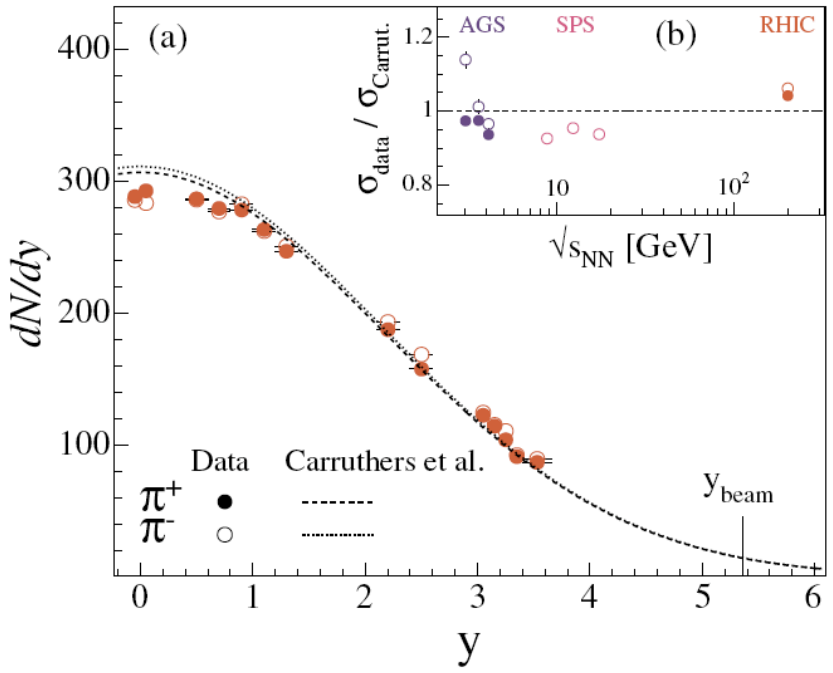
Scaling Solution:
(*not* restricted to Bjorken hydrodynmaics)

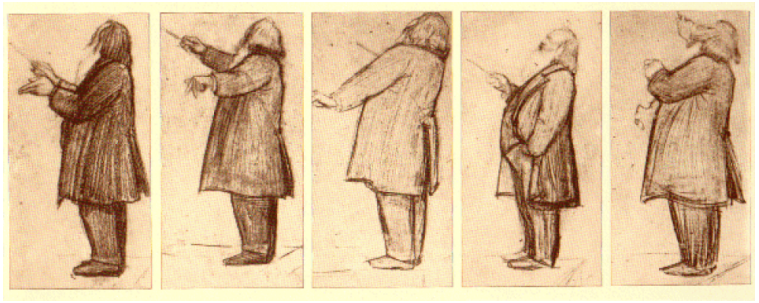
Fluid at/near position z at some time

$\Leftrightarrow$

Fluid velocity at/near some rapidity Y at that time

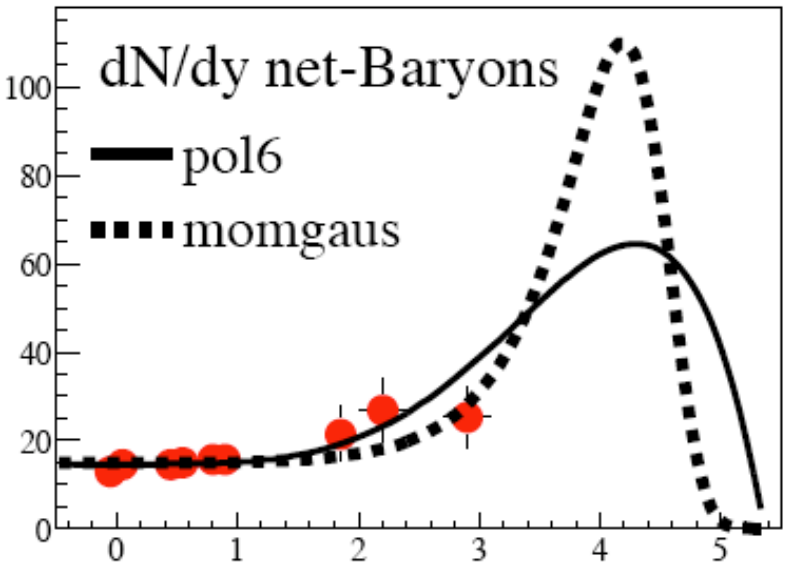
$$\left(\frac{n_B}{s}\right)_{\text{Initial}} = \left(\frac{n_B}{s}\right)_{\text{Final}} \approx C\,\frac{n_B}{n_\pi} = C\,\frac{dN^B/dY}{dN^\pi/dY} \equiv C\left(B/\pi\right)$$

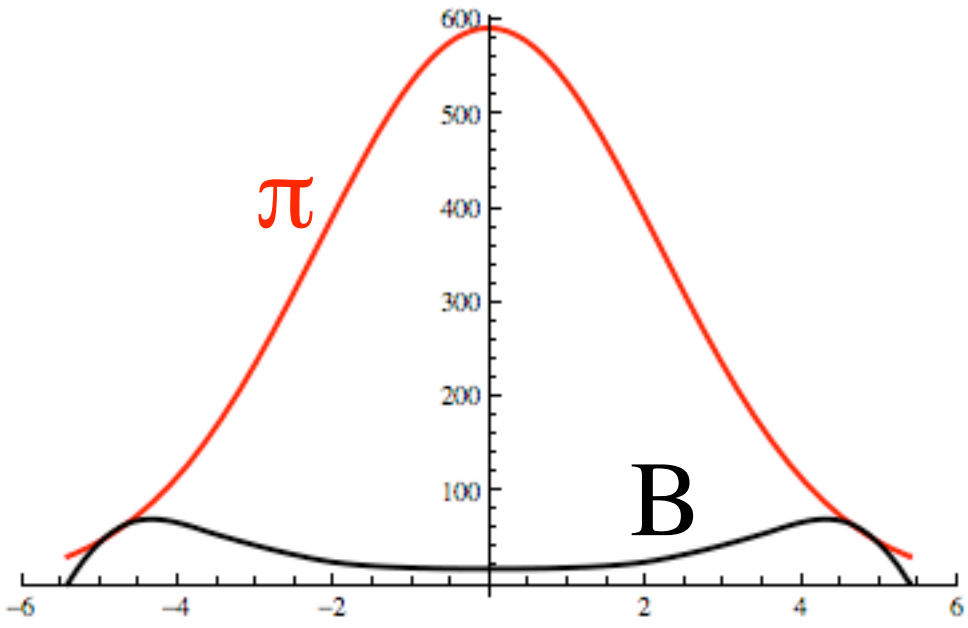




BRAHMS PRL 94 (2005) 162301

BRAHMS PRL 93 (2004) 102301



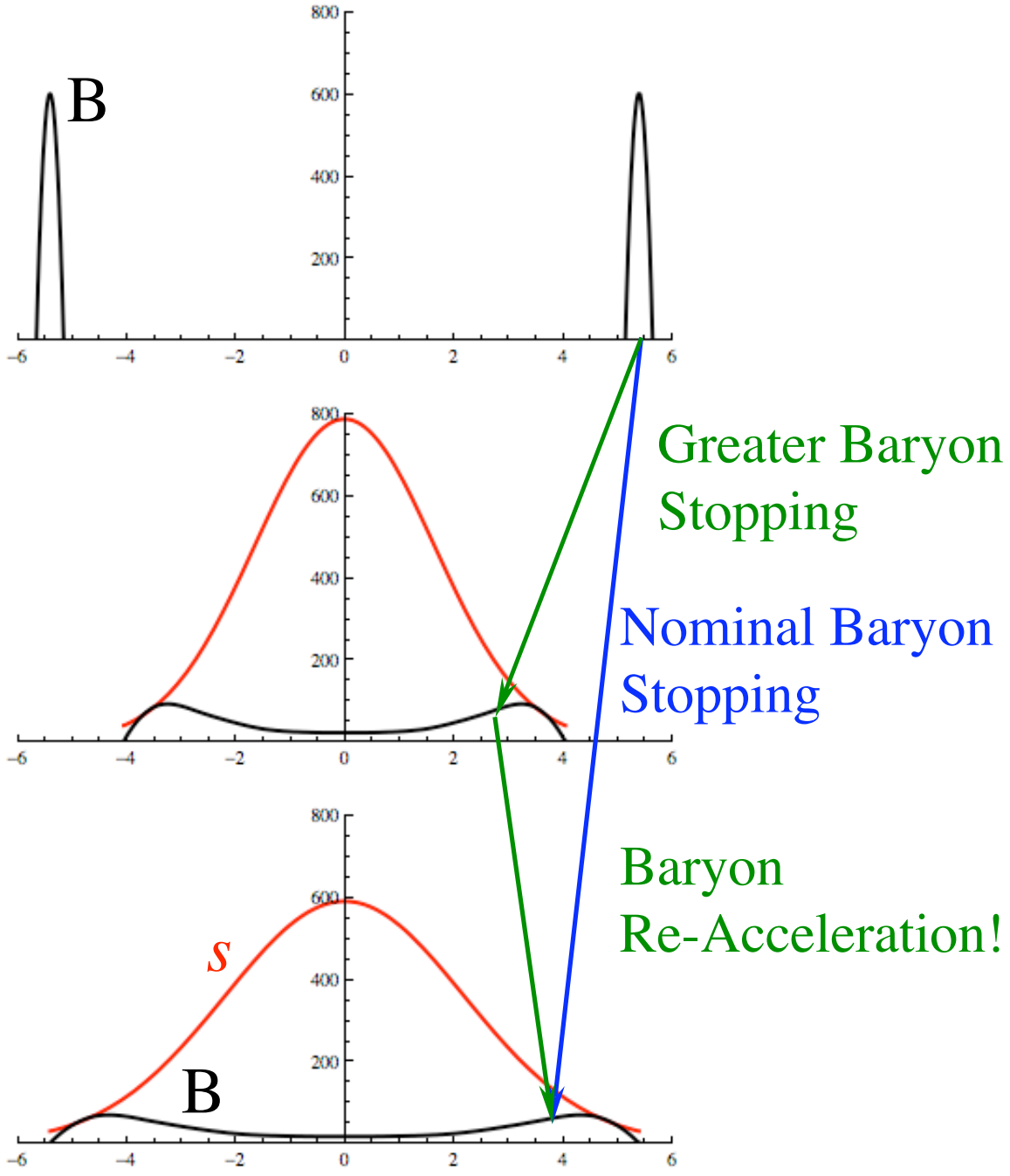


RHIC Au+Au 200 GeV Central

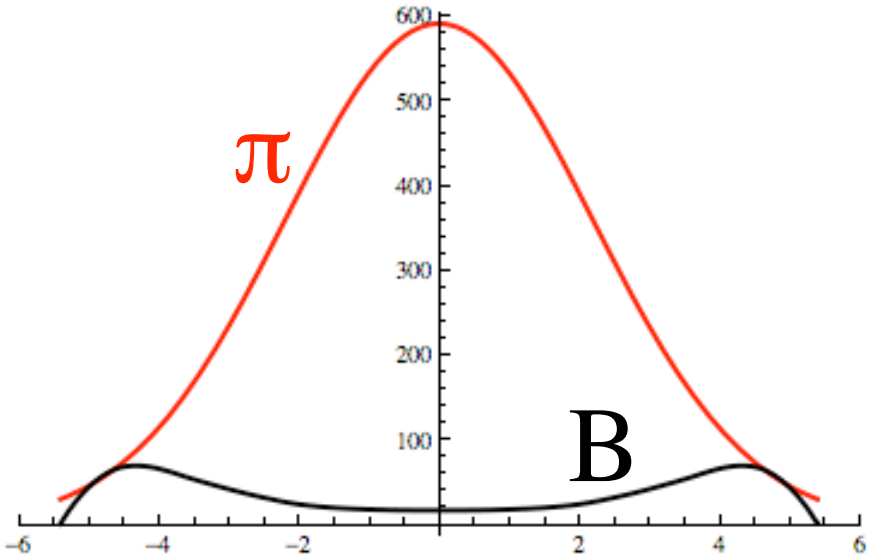
Initial

Early Hydro

Late Hydro

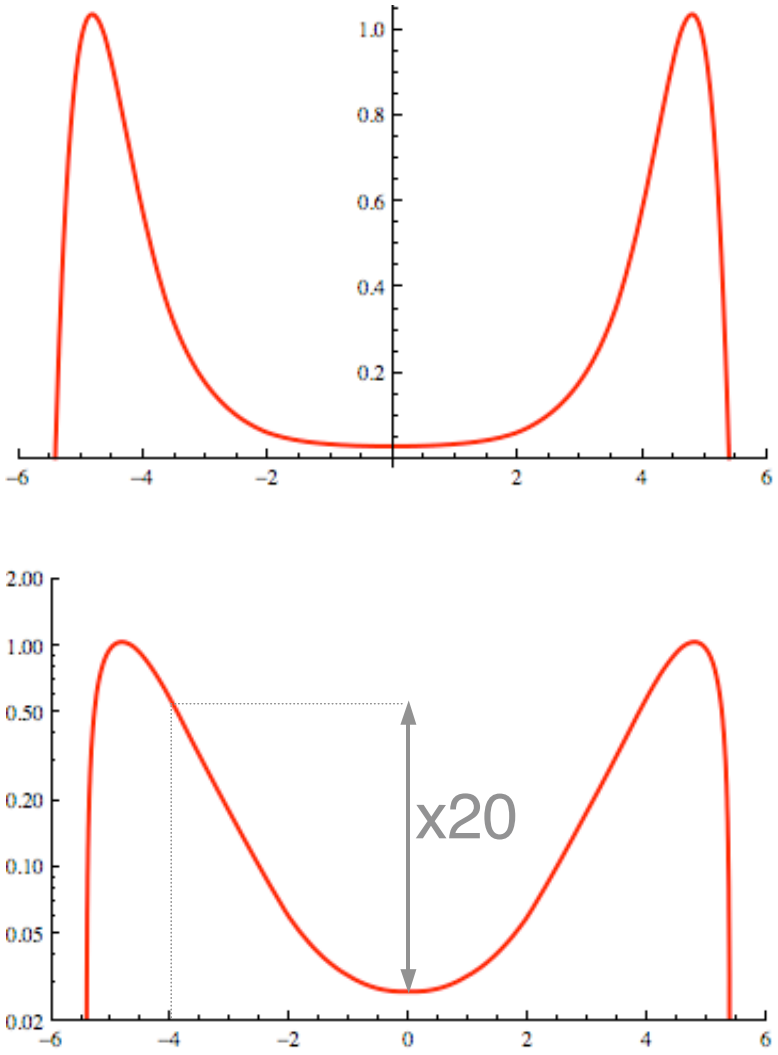


Rapidity Scan

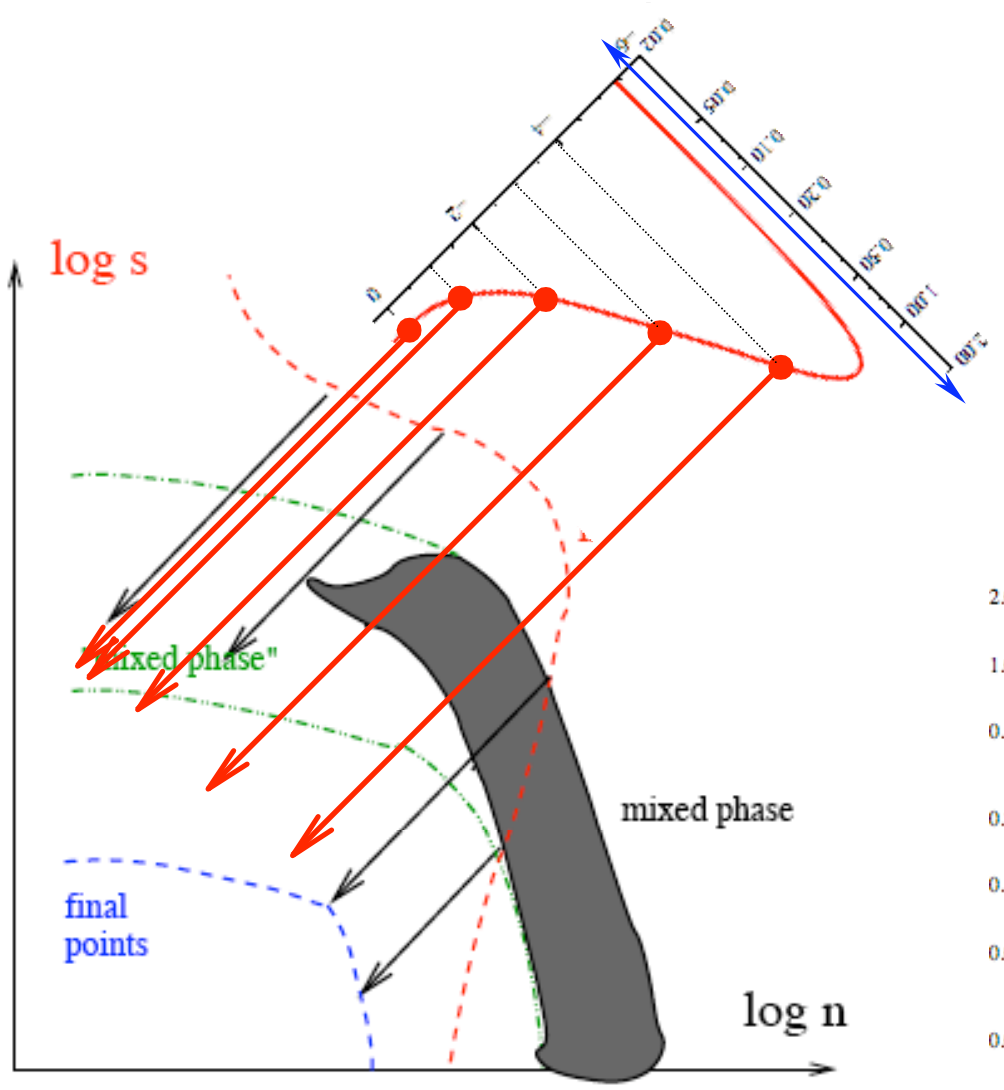


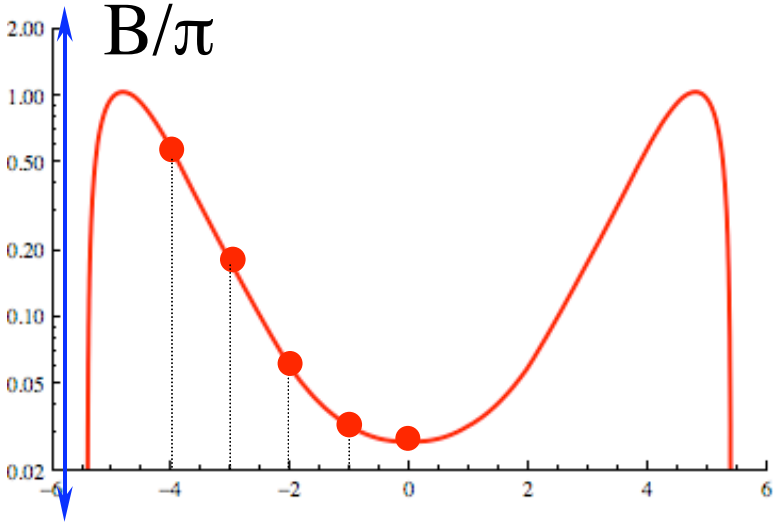
RHIC Au+Au 200 GeV Central

B/π



Every collision contains a scan!





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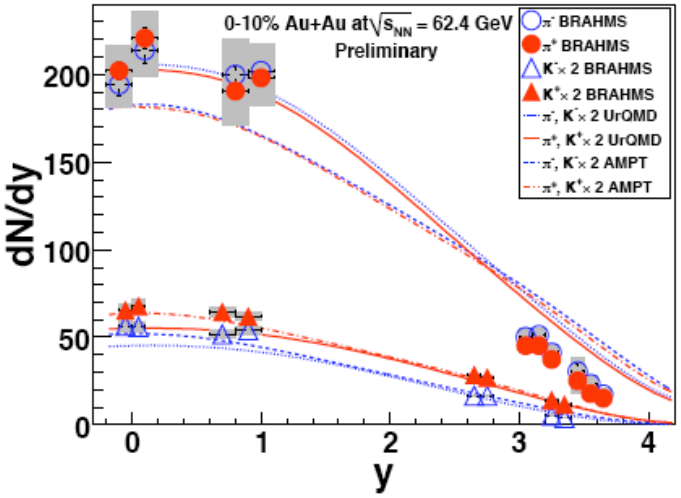

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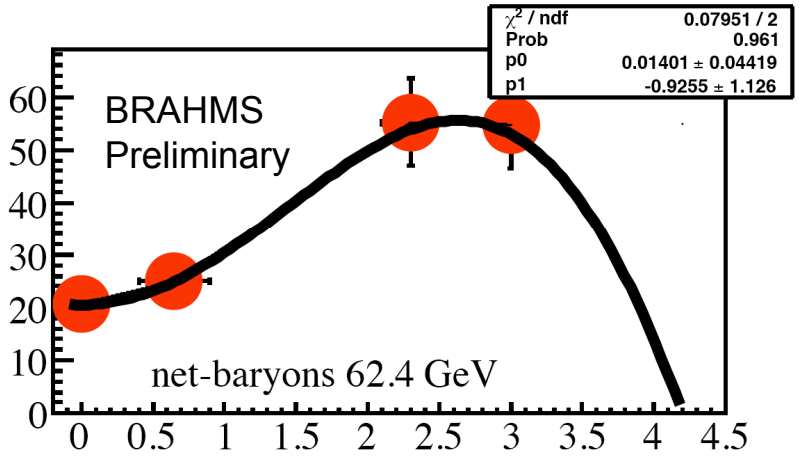

BRAHMS H.H. Dalsgaard QM2008

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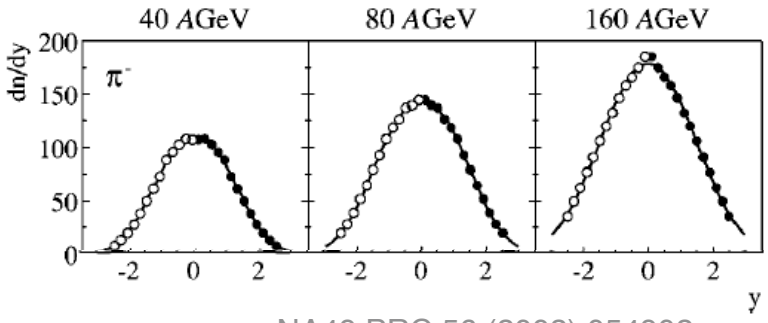
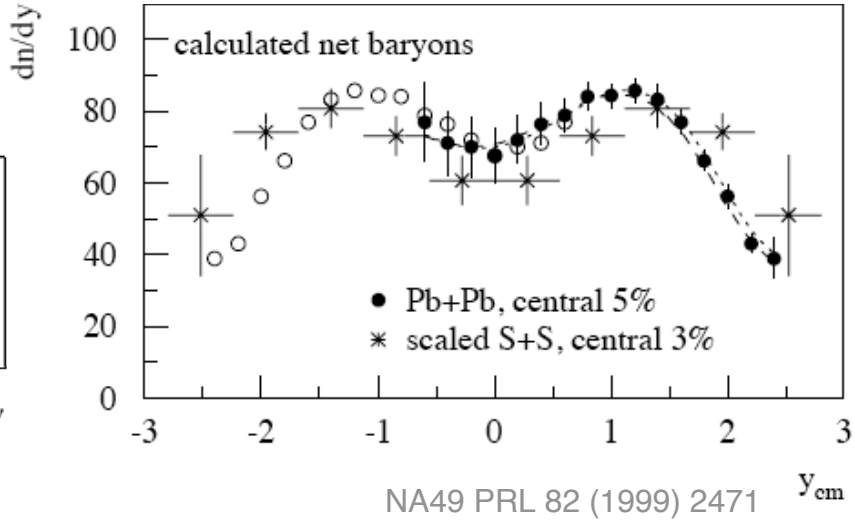
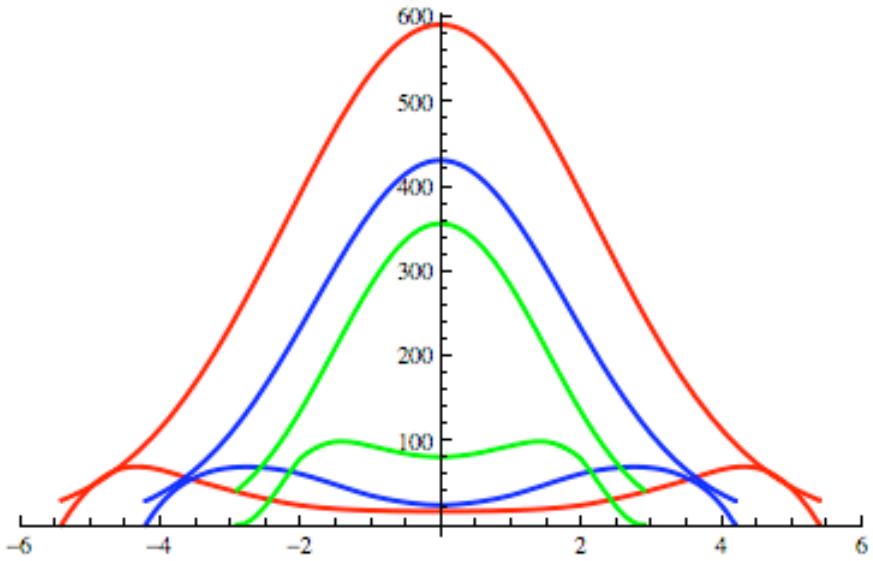


NA49 PRC 56 (2002) 054902



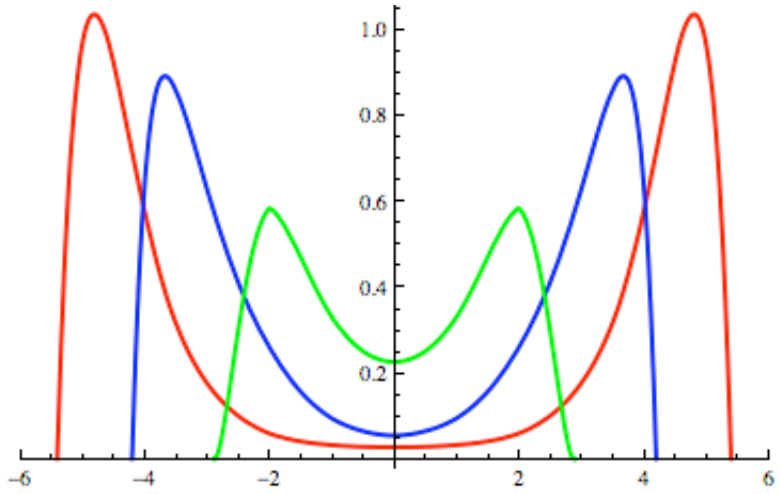
NA49 PRL 82 (1999) 2471

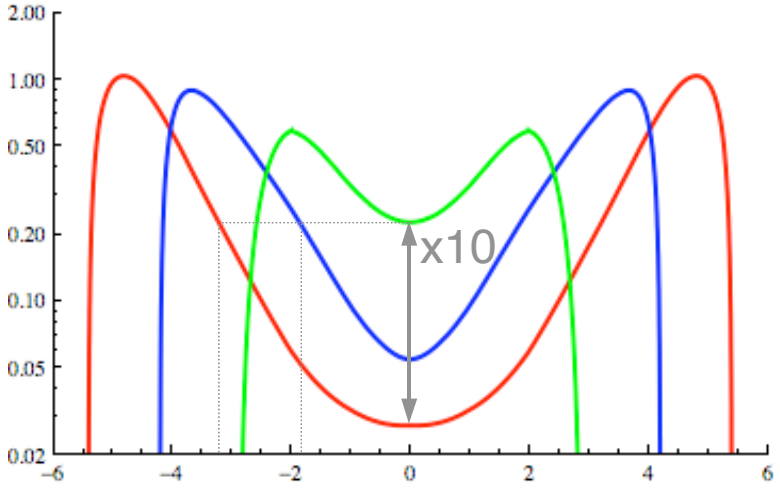
Beam Energy Scan



$\sqrt{s_{NN}}$ = 200 62 17

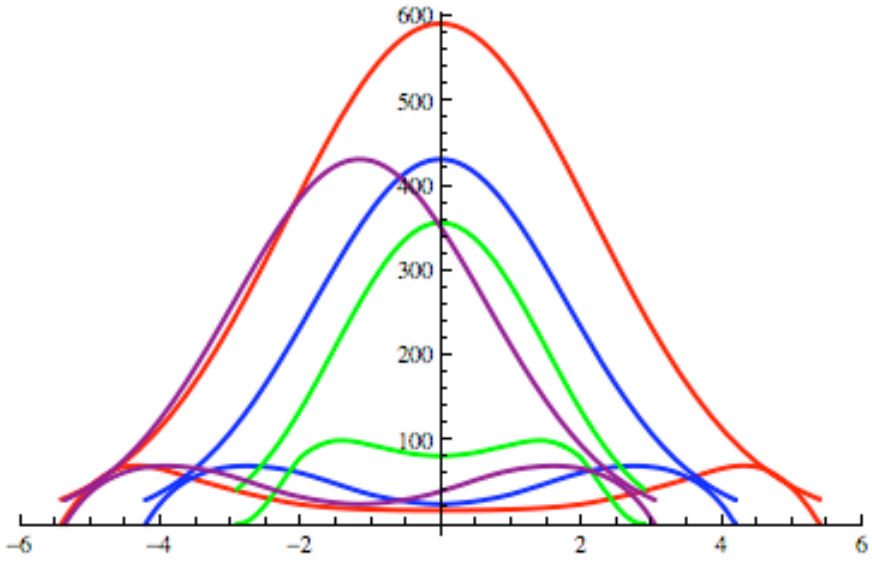
B/π





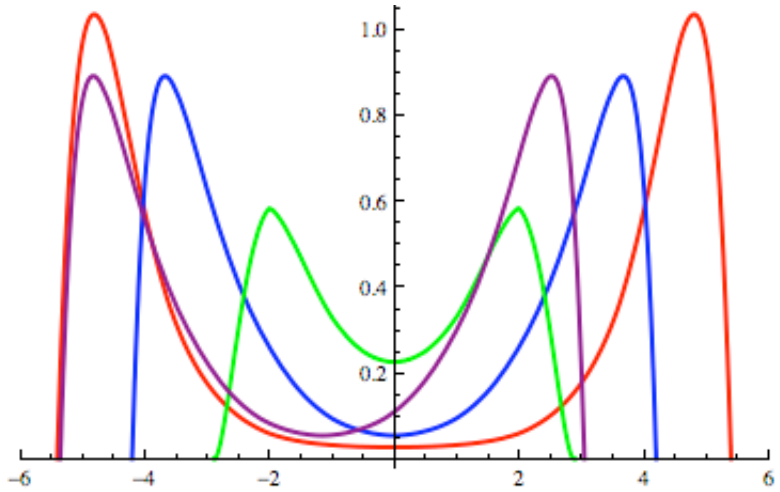
Asymmetric Beam Energies

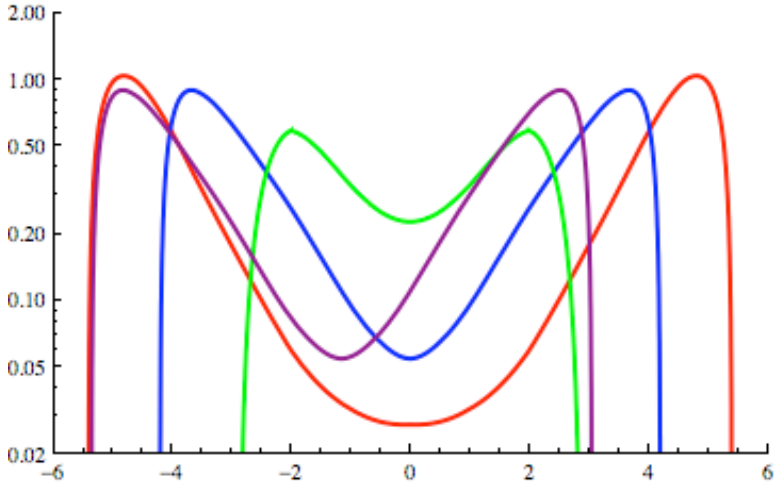
A 100 AGeV + 10 AGeV collision has $\sqrt{s_{NN}} \approx 60$ GeV and $\Delta Y_{CMS} \approx 1.15$



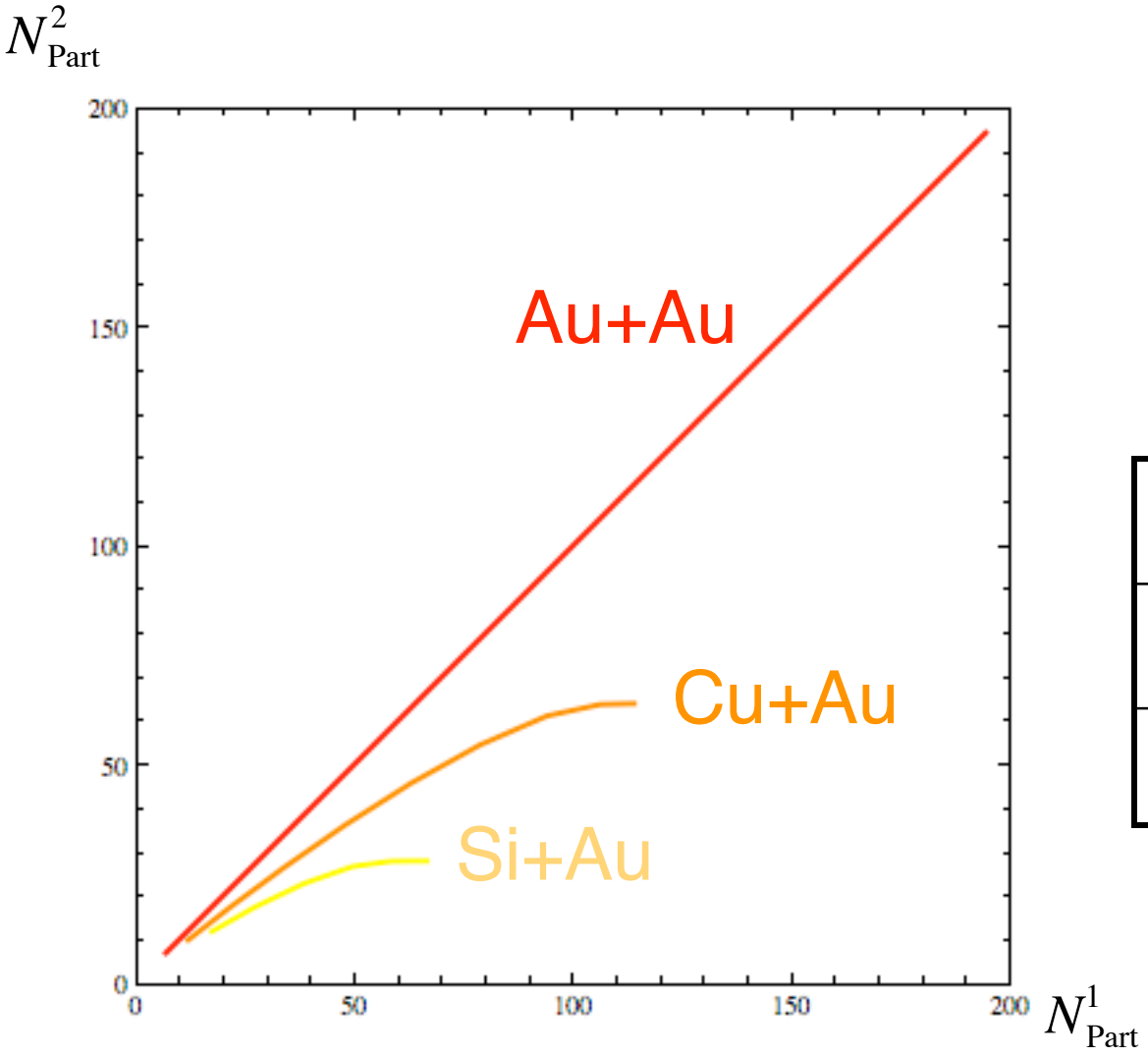
200 100+10 62 17

B/π





Asymmetric Ion Collisions: N_{Part}

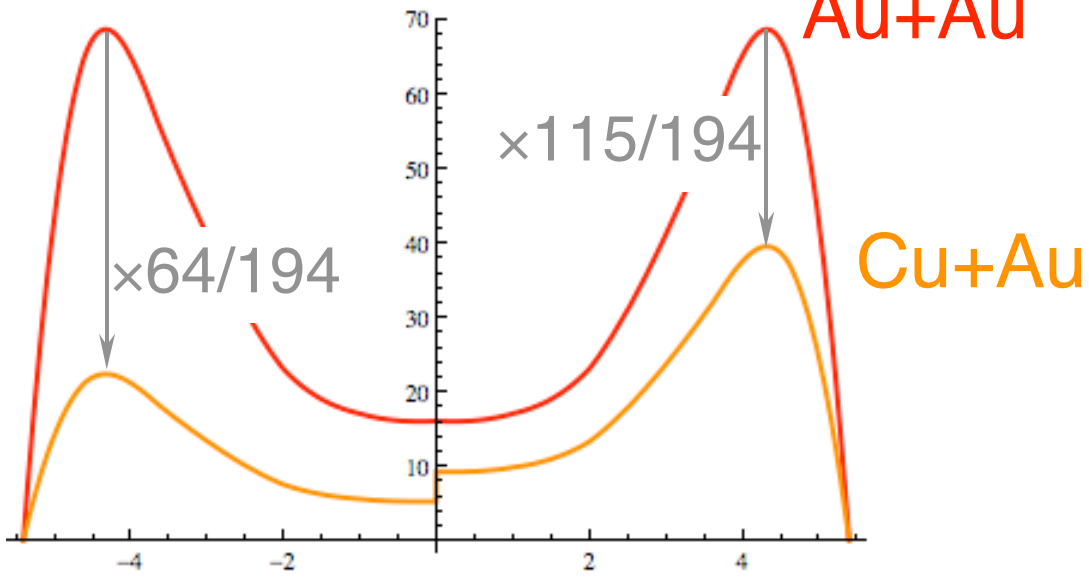


Central *b*=0

	N^1_{Part}	N^2_{Part}
Au+Au	194	194
Cu+Au	64	115
Si+Au	28	67

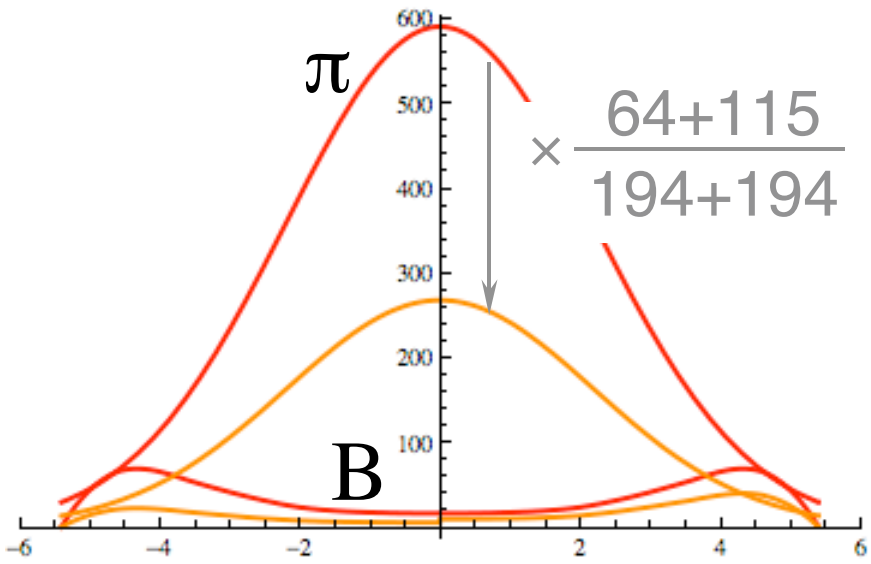
Asymmetric Ion Collisions: dN/dY

dN_B/dY



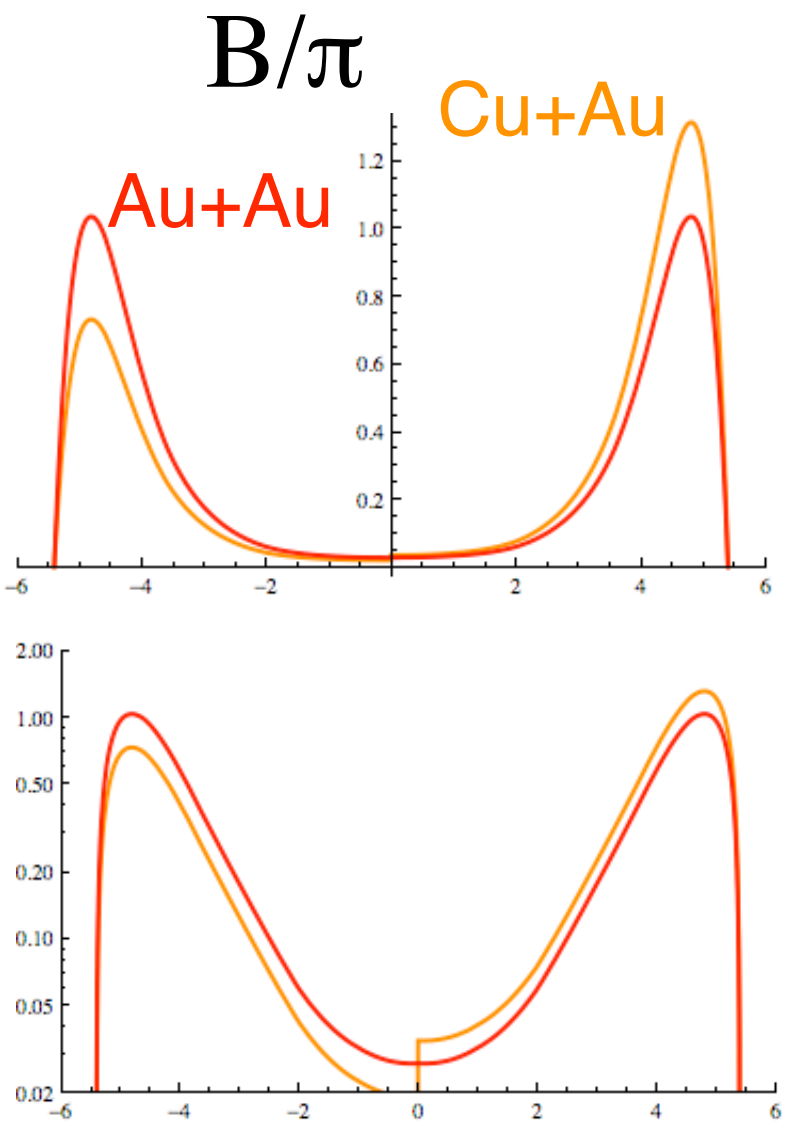
	N^1_{Part}	N^2_{Part}
Au+Au	194	194
Cu+Au	64	115

Assume: Each dN_B/dY scales as N_{Part}, and dN_π/dY scales as $N_{Part}{}^1+N_{Part}{}^2$

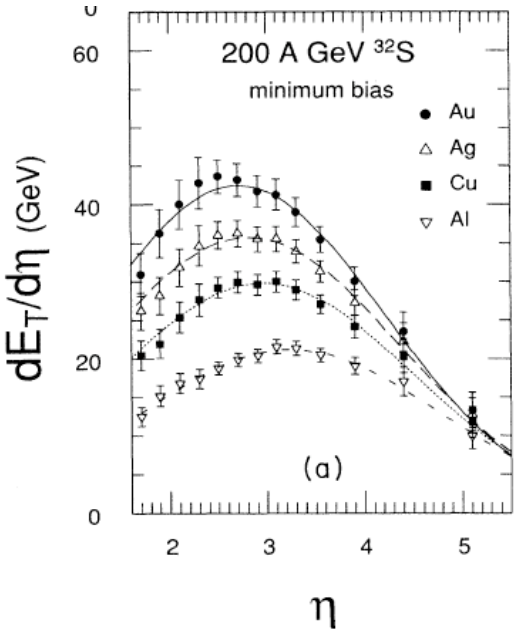


Asymmetric Ion Collisions: B/π

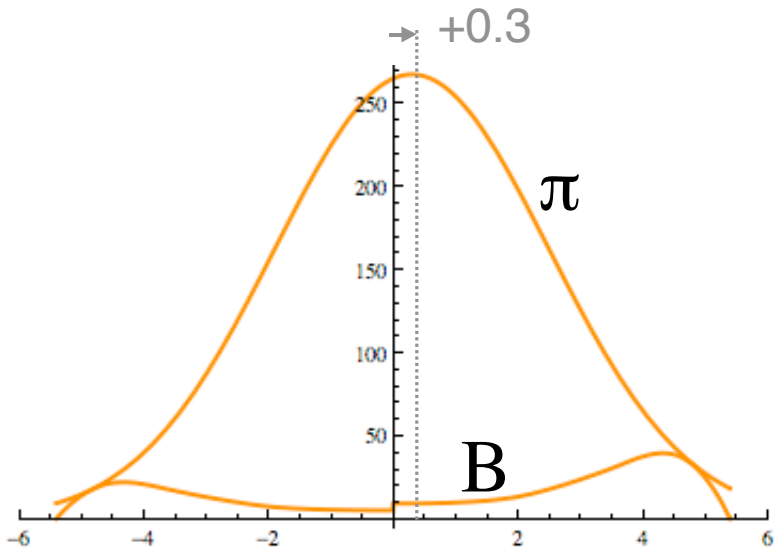
Under simple N_{Part} scaling, if $f \equiv N_{Part1} / N_{Part2}$ then B/π changes by a factor of 2/(1+f) relative to symmetric collisions.



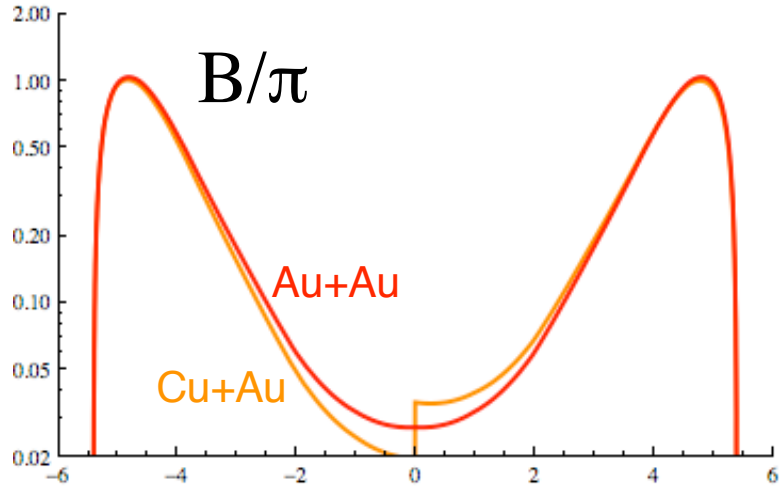
Shifting π's relative to B's



WA80 PRC 44 (1991) 2736



	N^1_{Part}	N^2_{Part}	ΔY_{Part}
Au+Au	194	194	0
Cu+Au	64	115	0.3
Si+Au	28	67	0.44



Summary:

1. For isentropic evolution, n_B/s is conserved for a fluid element. We can approximate n_B/s for a fluid element by B/π at some rapidity Y in the final state.
2. At full RHIC energy B/π is a strong function of rapidity, varying over a factor of ×20 from Y=0 to Y=4. Effectively every collision contains a scan in n_B/s.
3. Beam energy scans from top RHIC to top SPS vary B/π by about a factor of ×10 at mid-rapidity. Asymmetric beam energy collisions can shift the B/π pattern significantly.
4. Asymmetric ion collisions at RHIC are of fundamental interest for many reasons but don't provide much leverage in B/π, under simple assumptions.